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Role of Viscosity in Hydro-forming Process

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ABSTRACT

Hydro forming is new development in the manufacturing of various products in the field of engineering. In the manufacturing area one of the hydro forming process is Hydro forming deep drawing. Hydro forming deep drawing is one of sheet metal forming process to produce seamless shells, cups and boxes of various shapes. In this forming process, an additional element such as fluid pressure is to be contributes positively in several ways. In hydro forming deep drawing process, applying the hydraulic pressure on blank periphery in radial direction. It is obtained through the punch movement within the fluid chamber, which is provided in punch and die chambers. These two chambers are connected with the bypass path and it is provided in the die. During the process punch movement within the fluid chamber the pressure is generated in fluid and it is directed through the bypass path to blank periphery, the fluid film is created on the upper and lower surfaces of the blank and subsequently reduces frictional resistance and is to reduce tensile stresses acting on the wall of the semi drawn blank. The blank is taking at centre place in between blank holder and die surface with supporting of high pressurized viscous fluid. The radial stresses are produced in the blank in radial direction due to punch force applied on it. The shear stresses acted by viscous fluid on the both sides of blank, so apply viscosity phenomenon to this analysis. Due to the viscosity of fluid the shears stresses and shear forces acted on blank during drawing process. This viscosity used for determination of radial, hoop and drawing stresses in this process. The viscosity is maintained major role in hydro forming process. The blank holder pressure is controlled by the radial pressure of fluid and these are equal for uniform deformation of blank to obtained required shape and also elimination of failure of blank in deformation. Newton's law of viscosity is applied for this process for evaluation of stresses. The radial stresses are determined in terms of viscosity of castor oil, shear stresses, blank geometry and process parameters for magnesium alloy. The study on these stresses in castor oil medium with consideration of its viscosity.

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Keywords: Hydro forming, Radial stress, Shear stress, Deep drawing process, Viscosity

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1. INTRODUCTION

In general sheet metal blank is drawn over a die by a radiused punch in deep drawing process. As the blank is drawn radially inwards the flange undergoes radial tension and circumferential compression [1]. The latter may cause wrinkling of the flange if the draw ratio is large, or if the cup diameter-to-thickness ratio is high. A blank-holder usually applies sufficient pressure on the blank to prevent wrinkling [2]. Radial tensile stress on the flange being drawn is produced by the tension on the cup wall induced by the punch force. Hence, when drawing cups at larger draw ratios, larger radial tension are created on the flange and higher tensile stress is needed on the cup wall. Bending andunbending over the die radius is also provided by this tensile stress on the cup wall. In addition, the tension on the cup wall has to help to overcome frictional resistance, at the flange and at the die radius. As the tensile stress that the wall of the cup can withstand is limited to the ultimate tensile strength of the material. Hydraulic pressure can enhance the capabilities of the basic deep drawing process for making cups. The advantages of hydraulic pressure forming deep drawing techniques, increased depth to diameter ratio's and reduces thickness variations ofthe cups formed are notable. In addition, the hydraulic pressure is applied on the periphery of the flange of the cup, the drawing being performed in a simultaneous push-pull manner making it possible to achieve higher drawing ratio's than those possible in the conventional deep drawing process. Deep drawing is an important process used for producing cups from sheet metal in large quantities. In the field of hydro form deep drawing process the special drawing processes such as hydro-forming [3], hydro-mechanical forming [4], counter-pressure deep drawing [5], hydraulic-pressure- augmented deep drawing [6].The process is an automatic co-ordination of the punch force and blank holding force, low friction between the blank and tooling as the high pressure liquid lubricates these interfaces and elimination of the need for a complicated control system [7-12]. The pressure on the flange is more uniform which makes it easiest to choose the parameters in simulation. The pressure in the die cavity can be controlled very freely and accurately, with the approximate liquid pressure as a function of punch position, the parts can drawn without any scratches on the outside of the part and also obtained in good surface finish, surface quality, high dimensional accuracy and complicated parts. In the hydro forming deep drawing process the pressurized fluid serves several purposes are supports the sheet metal from the start to the end of the forming process, thus yielding a better formed part, delays the onset of material failure and reduces the wrinkles formation.

In this paper the radial stresses are evaluated in terms of viscosity of fluid, blank geometry, and process parameters for magnesium alloy and studied using above process theoretically. The viscosity phenomenon is considered for evaluation of the process.

2. NOTATION

r_p= Radius of punch r_{cp}= Corner radius on punch
r_d= Radius of die opening r_{cd}= Corner radius on die
t = Thickness of blank r_j= Radius of blank
σ_r= Radial stress σ_θ= Hoop stress
$d\theta$ = Angle made by element at job axis P_h = Blank holder pressure
P = Radial pressure of fluid
τ = Shear stress acting by the fluid on each side of element
2τ = Total Shear stress acted by the fluid on the Element
dr = Width of element
r = Radial distance of blank element from job axis